



# How to Improve SBIR Phase III Technology Commercialization Effectiveness: A NASA Glenn Internal Assessment

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## **Abstract**

Governmental departments and agencies with responsibilities for implementing the Small Business Innovative Research program under the auspices of the Small Business Administration, are now required to be more accountable for phase III performance. At NASA Glenn Research Center, internal, one-on-one interviews were conducted with seven contracting officer technical representatives who have managed one or more SBIR contracts through completion of phase II. A questionnaire consisting of nineteen questions was formulated and used for the above purpose. This self-assessment produced several comments, conclusions, and recommendations for consideration and potential application.

## **Introduction**

The Small Business Innovative Research (SBIR) program is managed by the Small Business Administration (SBA), Office of Technology. The SBIR program was enacted in 1982 as part of the Small Business Innovation Development Act.

The Small Business Administration describes SBIR as a “highly competitive program that encourages small business to explore their technological potential and provides the incentive to profit from its commercialization. By including qualified small businesses in the nation's R&D arena, hi-tech innovation is stimulated and the United States gains the entrepreneurial spirit as it meets its specific research and development needs. NASA is one of ten federal departments and agencies required by SBIR to reserve a portion of its R&D funds for awards to small businesses.” According to the NASA Glenn SBIR program manager, in fiscal year 1998, NASA invested over \$125 million in SBIR. At Glenn, the specific investment was on the order of \$15 million.

This review and assessment was requested by the Glenn SBIR program manager and authorized by the NASA Glenn Chief, Commercial technology Office. The study was not a requirement of the governing NASA or overall SBA, SBIR program management structure. In addition, the study did not encompass or represent the views of the entire agency; nor did it present an exhaustive, comprehensive, quantitative statistical study of the subject matter. Instead, it was a qualitative review and internal assessment which focused on the program's phase III information sources - that is, a sample of contracting officer

technical representatives (COTR's) who would be selected for an interview based on a review of phase III company performances.

A full, introductory description of the SBIR program and operational characteristics was not included in this report. This report begins with a description of the objectives. This is followed by a discussion of the approach. Findings are then elucidated and related conclusions are drawn. Finally, several recommendations are offered.

## **Objectives**

The objectives of this SBIR phase III review and internal assessment were to:

- determine whether NASA Glenn organizations could do more to increase SBIR phase III companies technology commercialization success potential; and
- identify any systemic, organizational, or financial problems/obstacles that may prevent phase III utilization or further development, (non-SBIR) contractual relationships.

The ultimate aim was to provide the NASA Glenn SBIR program manager with an indication of what if anything might be in Glenn's power to affect in order to increase the effective economic impact of Glenn's SBIR contribution to the U.S. economy.

## **Approach**

This phase III study was conducted with the assistance of SBIR support personnel who provided the required research data. The entire process had an approximate duration of three months.

A list of forty-three (43) companies which had completed phase II was obtained from the Glenn SBIR program office. Information was available across several qualitative and quantitative categories: success story (innovation, accomplishments, commercialization, and government/science applications); state; sales; jobs; and phase III funding.

Based on a thorough review of these top-level data, a sample of ten company records was selected for closer analysis. A "Request for Past Reports and Proposals" (specifically phase II) was sent to the SBIR program office. This secondary information was used to (1) provide some insight into each candidate company's proposed plan and ultimate accomplishment, and (2) help in the formulation of an interview questionnaire to be used in the conduct of an informal, primary data gathering interview with each respective COTR.

The ten companies, and their respective technologies, whose records indicated good, representational study characteristics were:

1. Advanced Ceramics Corp., Lakewood, OH (NAS3-27690)  
Technology: *Durable Interface Coatings for Ceramic matrix Composites*
2. AI Ware, Inc., Cleveland, OH (NAS3-26675)  
Technology: Design of Experiments Module
3. Clever Fellows Innovation Consortium, Inc., Troy, NY (NAS3-26603)  
Technology: Alternator and Suspension for Free Piston Stirling Engines
4. ExFlour Research Corp., Austin, TX (NAS3-24856)  
Technology: Perfluoropolyether Lubricating Fluids
5. Foster-Miller, Inc., Waltham, MA (NAS3-27385)  
Technology: *Lightweight Graphite/Aluminum (Gr/Al) Space Radiators for Thermal Management*
6. Geo-Centers, Inc., Newton, MA (NAS3-25817)  
Technology: *Fiber Optic Systems for Composite Process Monitoring and Control*
7. Precision Combustion, New Haven, CT (NAS3-26614; NAS3-25784)  
Technologies: (a) *Catalytic Ignition for Rotary Combustion Engines*; (b) *A Novel Approach to Catalytic Combustion*
8. Spire Corporation, Bedford, MA (NAS3-25146; NAS3-25798)  
Technologies: (a) *High Efficiency, Radiation-Resistant Indium Phosphide Solar Cells*; (b) *Indium Phosphide Solar Cells on Silicon Substrates*
9. The Technology Partnership, Grosse Ile, MI (NAS3-26844)  
Technology: *High Reliability Long-Term Lubricators*
10. Ultramet, Pacoima, CA (NAS3-25650; NAS3-25203)  
Technology: *High Temperature Oxidation-Resistant Thruster Materials*

Most of the specified reports and proposals for six (6) companies were received from the SBIR program office. However, records for the remaining four companies were unavailable, due to the fact that the program's archive was over sixteen years old.

Seven separate interviews were conducted with seven of the ten respective COTR's between December 7th and 22nd, 1998. (Three COTR's were unable to participate due to scheduling difficulties during the planned interview period of this study.) Since the author originally intended to derive results based on a sample of five interviews, the additional two were considered a bonus.

The interview consisted of nineteen (19) questions. The first three questions were general to elicit broad perspective responses; while the remaining sixteen explored the COTR's more focused recollections of his/her specific company-related and organizational contextual experience. The complete list of interview questions is presented below:

#### General

1. How many SBIR contracts have you managed or have been closely associated with (a) through phase I, (b) through phase II?
2. What is your view of the overall effectiveness or technology commercialization/business success rate of phase III companies?
3. What do you think Glenn (NASA) should/can do to increase the technology commercialization success potential of its phase III candidate companies?

### Company Specific

4. Were you satisfied with the company's phase II technology product?
5. Was the phase II technology product (end result) useful to Glenn/NASA?
6. Have you applied/incorporated the technology into any NASA program?
7. Have you advocated for the incorporation of the technology into any NASA program?
8. Do you plan to apply the technology?  
\*\*\*\*\*
9. Have you had any business inquiries/solicitations, technical assistance, or other interactions with the company since completion of this company's phase II?
10. Did the company propose an extended relationship after completion of phase II?
11. Would your organization have invested its own (non-SBIR) dollars in further developmental work with this company?
12. What has been the level of your organization's (non-SBIR) NASA program R&D funding since completion of this company's phase II contract?  
\*\*\*\*\*
13. Does the degree to which the technology is being applied outside of NASA meet with your expectations?
14. Have you received any indication that the company accomplished its phase III technology commercialization objectives?
15. Could the technology (company) have benefited from further development support (for NASA application objectives)?
16. What more (non-SBIR-wise) should/can Glenn do to increase the phase III effectiveness or technology commercialization potential of this company?  
\*\*
17. How many (non-SBIR) request for proposals (RFP's)/contracts does your organization issue per year?
18. Did the company indicate any interest in competing for follow-on, phase III (non-SBIR) contractual efforts for further NASA mission application?
19. Has your organization ever released a (non-SBIR) RFP's in this area of technology?

### **Findings and Conclusions**

The author appreciated the openness and thoughtfulness of the responses, which were given to all nineteen questions by each, respective COTR interviewee. In order to preserve the sanctity of the individual interchanges, no specific responses will be identified or attributed to any COTR. The findings are presented in a general manner from which broad conclusions may be drawn that might be applicable to the SBIR program in general. An attempt was made to interpret and briefly summarize or draw succinct conclusions. The reader is, of course, free to interpret and draw his or her own conclusions. It is hoped that the reader's own interpretations might agree with those of the author. Each conclusion offered is given in "Italics" after the respective statement of findings.

The interview questionnaire shown in the previous section was basically designed to provide insight into the subject COTR's experiences and perspectives in five areas of analytical interest: (a) overall satisfaction and relevance of the phase II technology product(s), (b) nature and extent of COTR involvement and interaction during phase II and into phase III, (c) organizational need and support for phase II product(s), (d) company follow-through and commercialization expectations, and (e) how to assist with commercialization realization. The findings of this report are discussed within the context of each of these areas.



Overall Satisfaction and Relevance of the Phase II Technology Product(s) - Related Questions: 4, 5, and 13.

Responses to question 4 revealed that of the nine phase II technology products (managed by seven COTR's) delivered, all were satisfactory. However, with respect to question 5, only one technology was considered "*superior*," three were described as "*potentially useful*," two were simply affirmative responses, and three were described as "*not useful*." Regarding question 13, seven technologies met expectations in applications found outside NASA.

*Conclusion: Overall, Internal (NASA) application satisfaction and relevance were low, and external application satisfaction and relevance was high.*

Nature and Extent of COTR Involvement and Interaction During Phase II and into Phase III - Related Questions: 6, 7, 8, 9, and 10.

Question 6 showed that six of the nine technologies had not been applied or incorporated into any NASA program. Questions 4 and 5 indicated that COTR's did provide some amount of internal NASA advocacy support for eight technologies, but they only planned to apply six toward their own research objectives. Only one COTR indicated not having any interactions with the company since completion of phase II. Most of the other responses ranged from responding to inquiries and providing a "*referral*" service. One of them however, described a very close relationship that facilitated a "*buy-out*" (i.e., large company acquisition) which was enormously beneficial and financially lucrative to the company, business-wise. Regarding question 10, four out of seven companies proposed some sort of extended relationship after completion of phase II. The "*buy-out*" candidate mentioned before was disappointed to learn of the lack of any formal phase III support. Other COTR's pointed to (the agency's new system of) "*full cost accounting*" as preventing an extended relationship, and being "*too busy*" to accommodate potential phase III support needs. One company obtained phase III support from another government agency.

*Conclusion: Most COTR's remained engaged with either the technology or the company in an indirect, marginal or informal manner, however, most companies or technologies could use a source of additional, formal phase III support if available.*

Organizational Need and Support for Phase II Product - Related Questions: 1, 11, 12, 15, 17, and 19.

Four of the seven COTR's responded negatively to question 11. The reasons given ranged from the loss of or "*no funding*," to the "*collapse*" of funded programs, which supported the development of the SBIR technology. One COTR said that it would have been "*too much*" for his organization to invest its own dollars. Instead, he would have attempted to secure funding from "aero" programs to support further "*exploratory*" work. Only one COTR secured organizational funding for a "*phase II augmentation*" through a "*sole-source*"

justification. In response to question 15, four technologies could have benefited from further development support for NASA application objectives. One COTR thought it would be difficult to justify, while the others pointed to funding limitations. Again, the sole-source recipient mentioned above was the only technology to actually receive and benefit from further support. For those who offered a rough estimate for question 12, the level of each COTR's respective NASA program R&D funding since completion of their phase II's varied widely: \$0K; \$100K; \$500K; \$1-1.2M; \$1-2M; up to \$5M (all branch level, per annum). For question 17, most estimates for (non-SBIR) RFP's/contracts issued per year, per organization were given at "0" or "1." One was given at "5" to "6." Finally, for question 19, all but one (sole-source above) response was negative. The following two similar comments are perhaps very representative: *"We rely on SBIR. Can't afford;"* and, *"Without SBIR, this couldn't have been done."*

*Conclusion: Organizational need and support are both low (and weak) due to a systematic lack of healthy budgets and the loss of programs and necessary programmatic pull within the agency during phase III.*

Company Follow-Through and Commercialization Expectations - Related Questions: 2, 14, and 18.

Most COTR's quantified their impressions of the overall effectiveness of technology commercialization (business) success rate of phase III companies. The estimates ranged from 10 percent, 40 percent, to as high as 50 to 60 percent. One COTR commented that *"every investigator does his own thing."* Another stated: *"If it is well thought out at the onset, and you can see a need for the product, then it will work well."* In response to question 14, five COTR's had received an indication that their respective company had accomplished its phase III technology commercialization objectives through licensing, large company buy-out, partnering, and other methods. It was interesting to note that the sole-source candidate (mentioned in another part above) was one of two companies that did not have a positive indication in this area. Their target customer has not generated a demand for the specialized product, and volume sales projections will probably not be realizable. For question 18, six of the seven companies did not indicate any interest in competing for follow-on, phase III (non-SBIR) contractual efforts for further NASA mission application. However, one COTR from this group stood out by noting that his company was very *"aggressive"* and *"would probably not have passed an opportunity."*

*Conclusion: Company efforts to follow-through with commercialization are high, but the resulting success rate appears to be low to medium.*

## How to Assist with Commercialization Realization - Related Questions: 3 and 16.

All COTR's were quite forthcoming with suggestions in response to question 3. In random order, the paraphrased suggestion(s) from each COTR are presented below:

- ◇ “(1) Senior NASA (R&D) personnel who know a lot of people (companies) - on a first name basis - can help bring the company in contact with potential ‘*continuation routes*’; (2) companies that get SBIR contracts need to be more “*business minded - its not what R&D you can do, but what you can sell*,” and (3) NASA can create (if it hasn't already) a web site with briefs of upcoming (technology) products so that other companies can “see” and (the) technology can be picked up early.”
- ◇ “(1) ‘*Commercialization panel*’ should include more venture capitalists; (2) ‘*no cost extension*’ to the phase II contract should be allowed; and (3) SBIR should not be forced to meet agency costing guidelines - there should be more flexibility in this area.”
- ◇ “(1) Disseminate the information in terms of success stories only - no more money; and (2) volunteer some sort of technical assistance on a ‘consulting’ basis (3-4/year; \$5K maximum cost; 2-4 week duration).”
- ◇ “COTR should be more involved in phase II in recommending or advocating SBIR results to users.”
- ◇ “(1) Get away from cottage industry, (2) broaden definition of success; (3) allow flexibility for company to redirect to some clearly viable commercial opportunity; (4) broaden NASA scope to increase company survival chances; and (5) both the company and NASA should perform market studies before.
- ◇ “(1) Establish a system to continue funding into phase III - perhaps modeled after the Air Force (the Air Force established a phase II-type contract for companies to continue work when no commercial market was apparent.); (2) establish some formal technical assistance; and (3) need to show business awareness and strategy guidance to small companies to help increase awareness and avoid exploitation (through license agreements) by large companies.”
- ◇ “(1) SBIR program should probably be expanded to provide phase III funding for ‘good’ phase II candidates; and (2) need to advertise (technologies) better to potential investors (both government and private).”

In response to the more company specific question 16, four COTR's provided additional suggestions which are quoted and/or paraphrased and presented in random sequence below:

- ⇒ “(1) ‘*Harden up*’ phase II selection - at the selection process for phase II, the process should be made more stringent (fast talkers can now get through the process - sell Brooklyn bridge); and (2) there should be good written documentation that phase II

would achieve phase III - that is, investments by venture capitalists or another company (phase III is about dollars - where will the dollars come from?).”

- ⇒ “Keep advocating for the company - travel a lot and talk to potential (aerospace or non-aerospace company) users.”
- ⇒ “(1) Select SBIR participants more narrowly - based on market; (2) get a genuine commitment from big companies that might actually buy items; and (3) some phase I’s have gotten ‘*too speculative*’ - they should be ‘*mature*’ enough to attract cash investment from a non-government (commercial) end-user.”
- ⇒ “NASA should help only if we could identify some niche application and we were to provide a large subsidy for bridging the cost - for NASA project application only.”

*Conclusion: In general, the effectiveness of phase III can be improved, and both the center/agency and the SBIR company have separate but related responsibilities. Basically, the Center/Agency can and should do more to facilitate and help assure commercialization realization for the nation’s (fairly significant) investment in SBIR developed technologies.*

## **Recommendations**

The SBIR program, as a whole, recently became formally responsible and accountable for tracking and measuring phase III performance, and advocating to support or encourage the commercial success of candidate (technologies) companies. By requesting this study, the NASA Glenn SBIR program manager took the initiative to expand his view of program performance, as required, and ascertain what might be done to improve SBIR technology commercialization effectiveness.

The “findings and conclusions” above clearly validated the assumptions underlying the governing objectives of this study that were stated in an earlier section. The author thinks that the results of this study provided a sufficient and substantial basis to offer a series of strong and independently verified recommendations to the NASA Glenn SBIR program manager. Furthermore, the author thinks that since the conclusions appear generally applicable to any organization that has an SBIR-type responsibility, alongside a technology commercialization interest, that the recommendations might also be generally applicable.

The following five recommendations for improving SBIR phase III technology commercialization effectiveness were formulated, predicated upon the findings and conclusions:

- Establish an open phase III support system that would allow highly successful phase II companies to obtain funded, technical assistance from (NASA Glenn) scientists and engineers. This system may be open through a competitive selection process, as needed, to (1) Glenn SBIR companies only, (2) Agency-wide SBIR companies; or (3) federal government-wide SBIR companies that have successfully completed phase II,

within a specified maximum timeframe. Funding for S&E support might come from either private or public (non-SBIR) sources based on a determination of company perceived technical risk.

- Either the Center SBIR program office or the Center commercial technology office should become the professional focal point for supporting, coordinating and facilitating SBIR phase III technology commercialization support activities pursuant to recommendation No. 1. If the commercial technology office assumes the responsibility, then the SBIR program office should remain a separate entity with the sole professional responsibility for executing, conducting and accomplishing phase I and phase II performance goals and objectives - thereby generating an input to the commercial technology office. On the other hand, if the SBIR program office assumes the responsibility, then it should establish the formal phase III program as a continuation of phase II - and provide advocacy to attract funding from non-SBIR sources.
- Considering the significant investment in SBIR technology development, it seems appropriate that Center scientists and engineers should be offered the opportunity to take one- or two-year details within the Center's SBIR program office or commercial technology office (if separate). In this official capacity, they could devote about 20 percent or more of their time toward fulfilling (i.e., jointly leading or supporting) the commercialization support needs of phase III companies - i.e., to formally provide a dedicated service as strategically networked and highly knowledgeable, market analysis and commercial technology "consultants," etc.
- The scientific and engineering "detailees" mentioned in recommendation No. 3 should draw support from at least one SBIR program office or commercial technology office permanent staff member, dedicated to SBIR phase III commercialization. Ideally, this staff member should possess the ability to operate in multi-disciplinary business and technological realms and focus about 50 percent or more (as required) of his/her time explicitly to Center-wide, SBIR phase III commercialization advocacy, etc. This staff member should be capable of organizing and (jointly) leading technology commercialization teams, as necessary, consisting of the SBIR (phase III) company, the former phase II COTR or other detailee, and other sources of technology marketing or commercialization expertise, as needed.
- NASA technical memorandum, TM-1998-208496, entitled "*The CommTech Methodology: A Demand-Driven Approach to Efficient, Productive and Measurable Technology Transfer*" describes a demonstrated, "technology pull" model which can perhaps be modified to serve all the above needs adequately. Basically, SBIR phase II output essentially becomes the "input" for the above model, along with some other key adjustments - given that SBIR phase III essentially has "technology push" characteristics. More applicable models are perhaps available from the Ohio Aerospace Institute (OAI), the NASA Regional Technology Transfer Centers (RTTC's) with some additional overhead cost. In addition, other potentially applicable models may be available from other government agency's (e.g. the Air Force), and private sector sources. The Journal of Technology Transfer has provided occasional coverage of public and private activities in this area. A full examination of all potential approaches or options and their required modifications was beyond the scope of this study.

It should be understood, though, that in presenting recommendations for improvement of the phase III product, the author made no attempt to remain within the scope of present SBIR program policy or structure. Notwithstanding that fact, it was not apparent that current SBIR program policy prevents an individual agency from lending formal assistance in phase III. In addition, certain comments above regarding “full cost accounting” appeared contrary to the present mandatory requirements of the Government Performance and Results Act of 1993, for example. Finally, no attempt was made to explore or forge alignment with the requirements of this (or any other) potentially relevant legislation. That was considered to be beyond the scope of this study.

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